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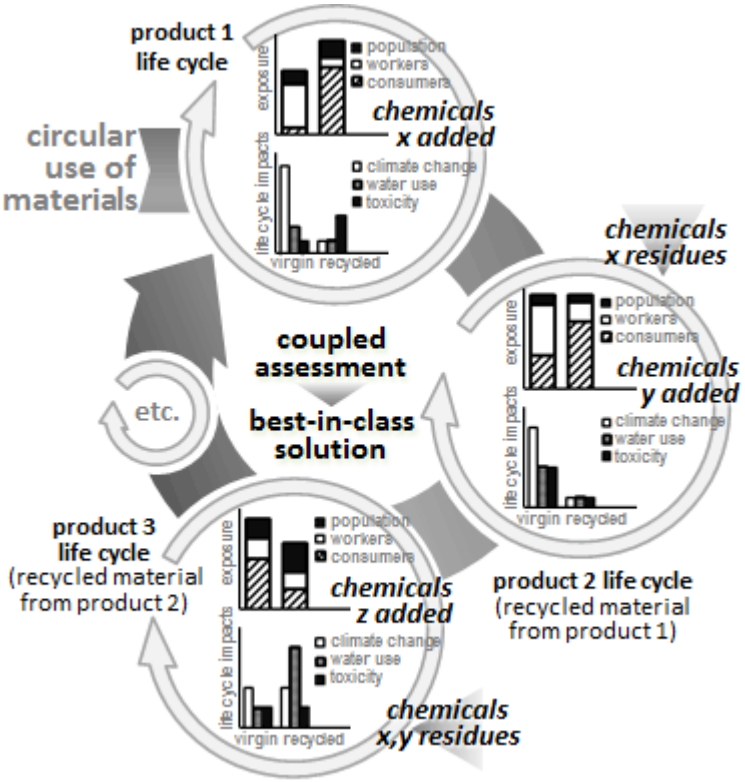
Increasing the sustainability of a globally connected economy is gaining wide attention in a world with limited natural resources and growing chemical pollution.[1] The circular economy has emerged as a way to reduce carbon and other emissions, while increasing resource efficiency over several product life cycles.[2] However, a circular economy is only viable if it is both safe and sustainable. The dilemma is that sustainable does not necessarily imply safe and vice versa. When minimizing exposure to harmful chemicals in consumer products (safe), we often use more energy-demanding alternative solutions (unsustainable). When maximizing resource use efficiency and reducing carbon and other emissions through recycling (sustainable), direct consumer exposure is often increased through cross-contamination of recycled materials (unsafe). Hence, circular economy currently fails to unite the required expertise to simultaneously increase sustainability and reduce exposure to chemicals in materials reused across life cycles of different products (see right-side Figure). For a way out of this dilemma, a paradigm shift is needed towards a comprehensive and quantitative assessment framework. In this framework, consumer, worker and population exposure is consistently coupled with life cycle impacts for materials used in consecutive product loops to identify sustainable and safe solutions for a viable, circular use of chemicals and materials.[3] This will help to achieve a safer and more sustainable circular economy through a targeted and efficient use of chemicals and materials. Based on identifying viable alternatives to harmful chemicals along material life cycles, this economy will be able to ensure controlled material recycling and successfully avoid the dilemma of safe but unsustainable or sustainable but unsafe solutions.



[1] Steffen et al. 2015. Science 347: 736-746
[2] Stahel 2016. Nature 531: 435-438
[3] Rappaport and Smith 2010. Science 330: 460-461